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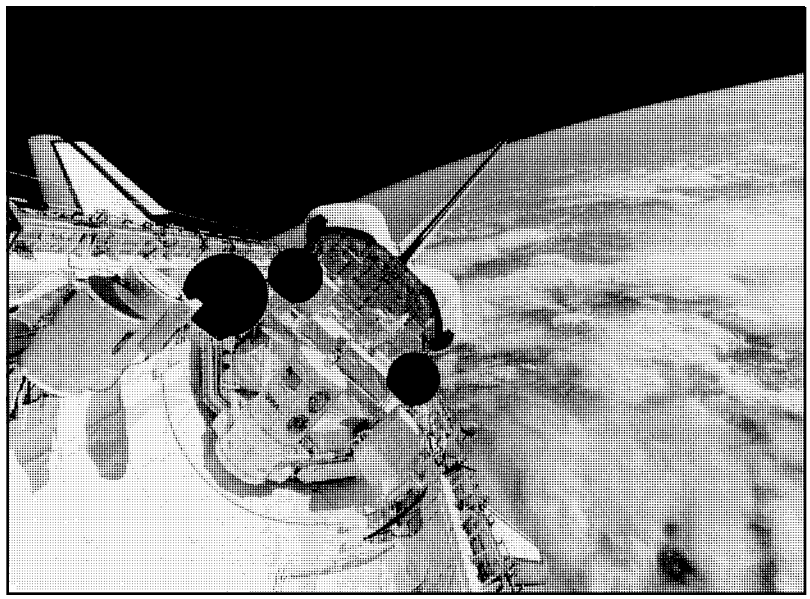
Mission Highlights STS-45

Space Shuttle *Atlantis*

March 24-April 2, 1992

Commander:
Charles F. Bolden, Jr. (Col., USMC)
Pilot:
Brian Duffy (Lt. Col., USAF)
Payload Commander:
Kathryn D. Sullivan (Ph.D.)
Mission Specialists:
David C. Leestma (Capt., USN)
C. Michael Foale (Ph.D.)
Payload Specialists:
Dirk D. Frimout (Ph.D.)
Byron K. Lichtenberg (Sc.D.)



ATLAS I instruments probe the mysteries of Earth's atmosphere

Major Mission Accomplishments

- First Space Shuttle mission to focus on Earth's atmosphere and its electromagnetic and solar environment in space. Carried 13 instruments designed to conduct 14 investigations in atmospheric science, solar science, space plasma physics, and astronomy.

- Provided a scientific "snapshot" of Earth's atmosphere that will be used by scientists over the next decade to understand periodic and episodic changes taking place within it.

- Created the first artificial auroras by injecting 7.4 kilowatt electron beams into the atmosphere below the orbiter where they produced 60 intense auroral displays several kilometers in diameter.

- Generated radio waves with 100,000 electron beam pulses and observed them with onboard receivers and with over 100 receivers on the ground in the U.S. and Japan.

- Provided scientific measurements that are being used to provide calibration information and complementary science for NASA's Upper Atmosphere Research Satellite and ozone-measuring instruments on NOAA meteorological satellites.

- Conserved sufficient orbiter power and consumables to permit the mission to remain in space an extra day and return 110 percent of the science results hoped for.

- Made SAREX (Shuttle Amateur Radio Experiment) contacts with amateur radio operators on all seven of Earth's continents. Using SAREX, the crew spoke to students in 17 schools in the United States and six other countries.

- First flight of a Belgian astronaut on the Space Shuttle.

The landing of the Space Shuttle *Atlantis,* with the STS-45 ATLAS 1 payload onboard, brought to a successful close the first chapter in a multi-year research program devoted to the study of Earth's atmosphere. Over the next eleven years, a complete activity cycle of the Sun, ATLAS (Atmospheric Laboratory for Applications and Science) missions will conduct important investigations in atmospheric and solar science. The ATLAS series will seek to provide vital data that will help atmospheric scientists understand the complex interactions taking place within and outside Earth's atmosphere. This information will help us understand global environmental problems such as ozone depletion and global warming.

STS-45 crewmembers (beginning bottom row, right and going clockwise) Charles F. Bolden, Kathryn D. Sullivan, David C. Leestma, Brian Duffy, Byron K. Lichtenberg, Dirk D. Frimout, and C. Michael Foale.

ATLAS 1 consisted of 13 instruments designed to conduct 14 investigations in a variety of scientific disciplines for scientists from the United States, Belgium, France, Germany, Japan, and Switzerland. Seven of the instruments will be carried into space on subsequent ATLAS missions. In this manner, each ATLAS flight will provide scientists with a "snapshot" of Earth's atmosphere that can be compared to gain a better understanding of the periodic changes that take place in the atmosphere. Furthermore, the data from these instruments will also provide insights to the effects episodic events, such as volcanic eruptions, have on the atmosphere. During ATLAS 1, the Atmospheric Trace Spectroscopy (ATMOS) instrument surveyed atmospheric trace molecules by measuring the effects they have on infrared radiation. Similar measurements were also taken by the GRILLE Spectrometer. The data from these two instruments revealed aerosol bands in the atmosphere that are probably remnants of the Mt. Pinatubo volcanic eruption in the Philippines last year. When the next ATLAS mission orbits Earth, it will be possible to survey those same remnants to determine how much they dissipated.

As a part of the 13 instruments of the ATLAS payload, *Atlantis* carried the Shuttle Solar Backscatter Ultraviolet Instrument (SSBUV-A) that has flown previously on three Shuttle missions. The SSBUV-A is similar to instruments on NIMBUS and TIROS satellites that measure ozone concentrations at various levels in the atmosphere. In time, data readings from these satellites fluctuate, making the accuracy of the readings suspect. Measurements taken by the SSBUV-A are being compared to those from the satellites to reestablish satellite instrument accuracy and to validate previously transmitted data.

In a similar vein, the Solar Ultraviolet Irradiance Monitor (SUSIM) and the Active Cavity Radiometer (ACR) provided data that will insure the continued accuracy of similar instruments on the Upper Atmosphere Research Satellite (UARS) which was launched in 1991 by the Space Shuttle *Discovery*. SUSIM made very accurate measurements of the Sun's ultraviolet radiation flow to learn how this radiation changes over time and relate those changes to changes in the atmosphere. The ACR instrument also measured ultraviolet radiation and, along with the Measurement of Solar Constant (SOLCON) instrument, provided a very accurate measure on the solar constant, the amount of energy the Sun constantly delivers to the atmosphere. Scientists theorize that changes in the constant of only 0.5 percent per century could lead to global climatic changes ranging from tropical to ice age conditions. The Millimeter Wave Atmospheric Sounder (MAS) instrument on ATLAS was also used for comparison with similar instruments on UARS. MAS recorded important measurements on ozone and chlorine monoxide, a key trace molecule involved in the destruction of ozone.

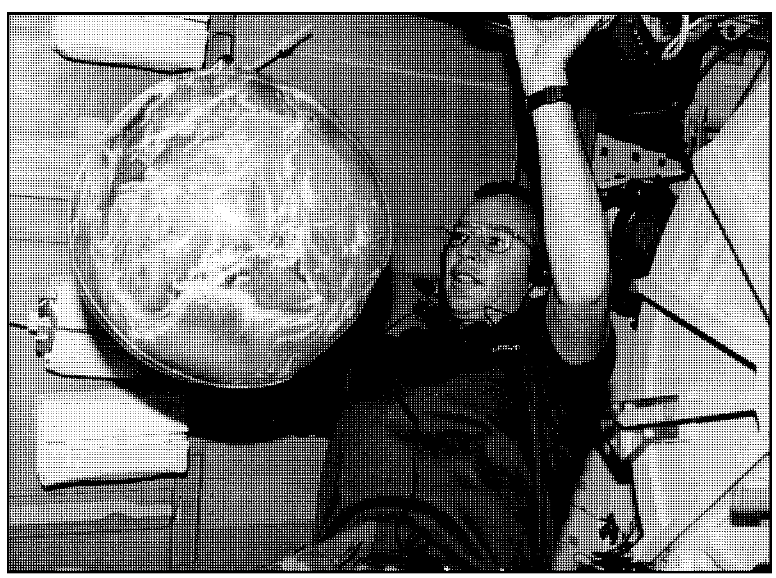
With two exceptions, all thirteen ATLAS 1 instruments had no major problems. In spite of blown fuses on two of the instruments (Far Ultraviolet Space Telescope or FAUST and Space Experiments with Particle Accelerators or SEPAC), all fourteen investigations supported by the instruments received significant data. The FAUST instrument provided astronomers with their first opportunity to explore wide areas of the sky in the far ultraviolet radiation wavelength range. Most ultraviolet light coming to Earth from space is filtered out by Earth's atmosphere, making it essential to travel into space to study this radiation first hand. Previous space-flown ultraviolet instruments have focused on narrow regions of the sky. Before its power failure, FAUST observed the nearby Large Magellanic Cloud galaxy to gain information that may help astronomers better understand the evolution of our own galaxy. A gas trail behind the cloud was observed that could indicate a region of star formation. FAUST also made observations of galaxy clusters in the Virgo, Telescopium, Dorado, and Ophicus constellations.

The SEPAC instrument was used for controlled experiments that were successful in generating the first artificial auroras ever produced in Earth's upper atmosphere. By firing a 7.4 kilowatt electron beam into Earth's upper atmosphere, electrons circling atmospheric nitrogen and oxygen atoms and molecules were excited to higher energy levels. As they returned to lower levels, they released light, forming high intensity auroras several kilometers in diameter. Forty of the sixty beams produced artificial auroras and were imaged by the Atmospheric Emission Photometric Imaging experiment mounted in *Atlantis*'s payload bay. The energy output of these auroras was greater than the energy input from the beam, indicating that the beam may have triggered larger reactions in the atmosphere. SEPAC was also used to investigate the interaction of ionized and neutral gases in space by injecting over 1,000 xenon gas clouds into the atmosphere. Furthermore, SEPAC generated radio waves with about 100,000 electron beam pulses. The pulses were observed by ATLAS 1 instruments and by over 100 receivers on the ground in the United States and Japan. In addition to the scientific observers, radio receivers, constructed by physics students in secondary schools in the United States and around the world by amateur radio operators, were also tuned to receive signals from SEPAC. Through the Interactive NASA Space Physics Ionosphere Radio Experiment (INSPIRE) students and their teachers attempted to pick up radio waves (whistlers) produced by the pulses. Although the success of the experiment was hampered by problems with the SEPAC instrument, students gained invaluable experience in constructing scientific instruments and planning for data collection.

STS-45 featured two additional educational activities. The Shuttle Amateur Radio Experiment (SAREX) was used to talk with students in 17 schools around the world (10 in the U.S. and its territories and schools in Belgium, Canada, England, Germany, Norway, and Wales). Three of the STS-45 crewmembers were even successful in establishing contact with amateur radio operators on all seven of Earth's continents. The other educational activity consisted of taping for an educational videotape on Earth's atmosphere. The program will be distributed to schools through NASA's Teacher Resource Centers during the next school year.

Several middeck science experiments were also conducted during the mission. Included were the Investigations Into Polymer Membrane Processing, Visual Function Tester II, and the Space Tissue Loss 1 experiments. The purpose of the Space Tissue Loss (STL) experiment was to study cell growth during space flight. Specifically studied were growth response of muscle, bone, and endothelial cells to microgravity. Scientists at the Walter Reed Army Institute of Research have reported excellent survival rates for heart muscle and immune cells. Study of the STL results will be used in the development of pharmaceutical products and physical treatment regimens to limit the extent of muscle tissue loss after fractures/cast immobilization and surgery.

As a result of conservation of orbiter fuel and consumables by the crew, the STS-45 mission was able to remain in space for one additional day. The extra day permitted crewmembers to gather 110 percent of the data originally planned for the mission and to broaden the geographic range of data collection.



Brian Duffy uses a world globe beachball in an educational videotape production.

Mission Facts

Orbiter: *Atlantis*
Mission Dates: March 24-April 2, 1992
Commander: Charles F. Bolden, Jr. (Col. USMC)
Pilot: Brian Duffy (Lt. Col., USAF)
Payload Commander: Kathryn D. Sullivan (Ph.D.)
Mission Specialist: David C. Leestma (Capt., USN)
Mission Specialist: C. Michael Foale (Ph.D.)
Payload Specialist: Byron K. Lichtenberg (Sc.D.)
Payload Specialist: Dirk D. Frimout (Ph.D.)
Mission Duration: 8 days 22 hours 9 minutes
Kilometers Traveled: 5,994,555
Orbit Inclination: 57 degrees
Orbits of Earth: 143
Orbital Altitude: 296 kilometers
Payload Weight Up: 8,044 kg
Orbiter Landing Weight: 93,113 kg
Landed: Kennedy Space Center
Payloads and Experiments:

- ATLAS I - Atmospheric Laboratory for Applications and Science
- SSBUV-A - Shuttle Solar Backscatter Ultraviolet Instrument
- CLOUDS - Cloud Logic to Optimize the Use of Defense Systems
- SAREX - Shuttle Amateur Radio Experiment
- IPMP - Investigations into Polymer Membrane Processing
- STS1 - Space Tissue Loss
- VFTII - Visual Function Tester
- Radiation Monitoring Equipment III
- Getaway Special Experiment

Educational Activities

- Educational videotape production

STS-45 Crew Patch

Crew Biographies

Charles F. Bolden, Jr. (Col., USMC). Charles Bolden was born in Columbia, South Carolina. He earned a bachelor of science degree in electrical science from the United States Naval Academy and a master of science in systems management from the University of Southern California. After graduation, Bolden became a naval aviator and later a test pilot. He has logged more than 5,000 hours flying time. Bolden became an astronaut in 1981 and has flown in space twice previously, as pilot of the STS-61C and STS-31 missions.

Brian Duffy (Lt. Col., USAF). Brian Duffy was born in Boston, Massachusetts. He received a bachelor of science degree in mathematics from the U.S. Air Force Academy and a master of science degree in systems management from the University of Southern California. Upon graduation Duffy completed pilot and test pilot training. Duffy became an astronaut in 1986. This was his first space flight.

Kathryn D. Sullivan (Ph.D.). Kathryn Sullivan was born in Paterson, New Jersey, but considers Woodland Hills, California her home. She earned a bachelor of science degree in Earth sciences from the University of California, Santa Cruz, and a doctorate in geology from Dalhousie University (Halifax, Nova Scotia). Dr. Sullivan is an oceanography officer in the U.S. Naval Reserve and an Adjunct Professor of Geology at Rice University, Houston, Texas. Dr. Sullivan became an astronaut in 1979 and has flown previously as a mission specialist on STS-41G and on STS-31.

David C. Leestma (Capt., USN). David Leestma was born in Muskegon, Michigan. He graduated from the U.S. Naval Academy and earned a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School. He then became a naval aviator. Prior to this mission, Leestma served as a mission specialist on the crews of STS-41G and STS-28.

C. Michael Foale (Ph.D.). Michael Foale was born in Louth, England, but considers Cambridge, England, to be his hometown. He attended the University of Cambridge, Queens' College, receiving a bachelor of arts degree in physics and a doctorate in laboratory astrophysics. Foale joined NASA Johnson Space Center in 1983 in the payload operations area of the Mission Operations Directorate. He was selected as an astronaut in 1987. This was his first space flight.

Byron K. Lichtenberg (Sc.D.). Byron Lichtenberg was born in Stroudsburg, Pennsylvania. He received a bachelor of science degree in aerospace engineering from Brown University, a master of science degree in mechanical engineering from MIT, and a doctor of science degree in biomedical engineering from MIT. Upon receiving his undergraduate degree, Lichtenberg entered the Air Force and became a pilot. He served as a payload specialist on the STS-9 (Spacelab-1) mission. This was his second flight.

Dirk D. Frimout (Ph.D.). Dirk Frimout was born in Poperinge, Belgium. He received the degree of electrotechnical engineer at the State University of Ghent (Belgium) and a doctorate in applied physics from the University of Ghent. He performed post-doctoral work at the University of Colorado, Laboratory of Atmospheric and Space Physics. Dr. Frimout is senior engineer in the Payload Utilization Department of the Columbus Directorate of the European Space Agency (ESA) and has been responsible for ESA support to the European experiments on ATLAS-1 since 1985. He was selected as a flight payload specialist in 1991. This was Dr. Frimout's first space flight.